



Fact Sheet

United States Nuclear Regulatory Commission

Office of Public Affairs

Washington DC 20555

Telephone: 301/415-8200 E-mail: opa@nrc.gov

Probabilistic Risk Assessment

Background

The Nuclear Regulatory Commission's (NRC's) responsibility is centered on ensuring that there is no undue risk to the health and safety of the public associated with the operation of nuclear power plants, or other facilities which it licenses. It does this by the application and enforcement of a set of technical requirements on plant design and operations, described in Title 10 of the Code of Federal Regulations (10 CFR). Generally, these are written in terms of traditional engineering practices such as "safety margins" in design, construction, and operations.

Probabilistic Risk Assessment (PRA) is a systematic process for examining how engineered systems, built and operated based on these requirements and practices, and human interactions with these systems work together to ensure plant safety. This process is quantitative, in that probabilities of events with potential public health consequences are calculated, as are the magnitudes of these potential health consequences. The risk of such events is the product of the event probabilities and their consequences. Information on this risk, and what failures contribute most to the risk, is a great value to the NRC in helping to determine the acceptability of a licensed facility's overall design and operation, as well as in focusing the agency's and the regulated industry's resources on those aspects of design and operation which are most risk-important.

Recognizing the potential utility of PRA, the NRC has supported the development and use of this and related techniques since the agency's establishment in 1975. The NRC has issued two key policy statements to better define the role of PRA:

- 1) The Safety Goal Policy Statement was issued in 1986, defining what the agency judges to be an acceptable level of risk from all nuclear power plants.
- 2) The PRA Policy Statement was issued in 1995, encouraging the use of PRA in a manner that complements traditional engineering practices.

The NRC now makes use of PRA techniques, guided by the Safety Goal and PRA Policy Statement, to improve its regulatory processes and decision-making. This use is discussed in more detail below.

Probabilistic Risk Assessment Methods

PRA as an analytical tool includes consideration of the following:

- ☐ Identification and delineation of the combinations of events that, if they occur, could lead to an accident (or other undesired event);
- ☐ Estimation of the chance of occurrence for each combination; and
- ☐ Estimation of the consequences associated with each combination.

As practiced in the field of nuclear power, PRAs generally focus on accidents which can severely damage the power plant's reactor core (containing the largest amount of radioactive material in the plant) and can also challenge the surrounding containment structures, since they pose the greatest potential risk to the public. This technique, or related risk assessment techniques, can be used, however, in the evaluation of all aspects of the fuel cycle, from fuel fabrication to high-level waste disposal. The PRA integrates into a uniform assessment tool the relevant information about plant design, operational practices, operating history, component reliability, human performance, the physical progression of core-damage accidents, and the potential environmental and health consequences in as realistic a manner as practical.

PRA accounts for certain processes and phenomena that may have never occurred, or may occur infrequently, and may involve severe conditions that are difficult to replicate in experiments. Similarly, data on component or human behavior may not be available in sufficient quantities or for the circumstances of concern. Therefore, the results are inherently uncertain. PRA illuminates these uncertainties and provides a way of considering them in regulatory decisions. The degree to which a detailed uncertainty analysis may be required will vary with the nature of the regulatory decision involved. Thus, analyses which depend only on the ability to separate the important from the obviously unimportant (e.g. prioritizing inspection efforts) may require only a general understanding of the magnitude of the uncertainty. Other applications, such as decisions regarding plant backfits, may require detailed uncertainty analyses.

Probabilistic Risk Assessment Uses

NRC has developed a plan, called the PRA Implementation Plan, for applying PRA technology in the U.S. nuclear power industry, consistent with the goals and objectives of the agency's PRA Policy Statement and Strategic Plan. The PRA plan, which is periodically updated, contains a listing of all on-going PRA initiatives designed to risk-inform NRC regulatory activities. The

table below provides a listing of the activities and recent accomplishments associated with the plan. This information is updated on NRC's website at:

<http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2003/secy2003-0044/attachment1.pdf>

	Table of Accomplishments
Activity	Accomplishment
Reactor Oversight Process (ROP)	Based on its assessment of stakeholder feedback and the results and lessons learned from annual self-assessments, the staff has developed a much greater level of confidence that the ROP has met the Commission's direction to develop an oversight process that is more objective, risk-informed, understandable, and predictable. The most recent self assessment concluded that the risk-informed ROP helps the industry and the NRC to focus resources on areas of the most safety significance. The staff has identified areas for improvement of performance indicators and of the significance determination process (SDP) and has developed plans to accomplish those improvements. Enhanced guidance in the use of the reactor safety phase 2 SDP has been issued and associated inspector training was completed. New guidance for the conduct of SERPs was also implemented. Additionally, important changes are being incorporated into the containment, shutdown and fire protection SDPs to provide inspectors with simpler methodology to assess findings. Note: The accuracy of approximating the risk associated with the reactor safety findings using the SDP phase 2 evaluation was challenged through a DPV and DPO. Similar concerns were expressed in an OIG audit. The staff responded by chartering an independent task group to review the phase 2 process and make recommendations.
Special Treatment Requirements	The staff completed preparation of the proposed rule package as sent to the Commission in SECY-02-0176 (September 30, 2002). A Commission briefing was conducted on November 21, 2002. The proposed rule package includes a draft regulatory guide (DG-1121) providing staff comments and clarifications on the industry-proposed implementation guidance contained in Draft Revision C of NEI 00-04.
10 CFR Part 50.44	The staff has completed a detailed technical review that provided the basis for proposed risk-informed changes to the rule. The improved realism supports the agency's decision to eliminate requirements for equipment that is not important to safety. On August 2, 2002, proposed rulemaking was published in the <i>Federal Register</i> (67 FR 50374.) Many letters were received during the public comment period that closed on October 16, 2002. The staff is currently categorizing and evaluating the comments.
PRA Quality	The staff has been working closely with ASME, ANS, NFPA, and NEI to develop standards for PRA quality and PRA review. Since the July 2002 version of the RIRIP, staff has prepared a draft regulatory guide, DG-1122, to provide guidance to licensees on the quality needed for PRA information used in risk-informed applications. This guide also addresses the staff's positions on the ASME PRA Standard and the industry's guidance on PRA peer reviews. The draft guide has been issued for public comment. An associated draft standard review plan chapter has also been prepared for public comment.
10 CFR Part 50.46	The staff has completed the technical studies for each of the proposed changes to 50.46 and its associated rules. The technical reports related to ECCS evaluation criteria (Appendix K), ECCS acceptance criteria, and ECCS functional reliability (GDC 35) were completed in June and July 2002. The recommendations are currently being reviewed by a working group dedicated to drafting the draft rules. The technical work for developing LOCA frequencies to be used for ECCS functional reliability work is still ongoing. Also, the assessment of the feasibility of redefinition of the spectrum of pipe breaks relevant to 10 CFR 50.46 is ongoing.

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Risk-Informed Technical Specifications	The staff continues to work on the risk-informed technical specification initiatives. The Combustion Engineering Owners Group (CEOG) topical report and Boiling Water Reactor Owners Group (BWROG) topical report safety evaluations for Initiative 1, Technical Specification Actions End State Modifications, and the Initiative 3, Modification of Mode Restraint Requirements, safety evaluation have been completed. The industry owners groups (OGs) are working on proposed technical specifications changes for Initiatives 1 and 3. A CEOG submittal for Initiative 6, Modification of LCO 3.0.3 Actions and Completion Times, has been received and the staff has requested additional information. After receipt of the requested additional information, the staff will complete a safety evaluation report. The OGs will subsequently prepare proposed changes to the standard technical specifications.
Reg. Guide 1.174/SRP Chapter 19	Since the July 2002 version of the RIRIP, Revision 1 of RG 1.174 and SRP Chapter 19 was completed and issued. This represents the first revision of these documents since their initial publication in July 1998. The following changes were included in the revisions: 1. Risk related information may now be requested if new, unforeseen hazards emerge or prospects increase substantially for known hazards. 2. Indication was provided of on-going staff discussions on the potential effect of increases in fuel burn-up and use of mixed-oxide fuel on risk metrics, such as large early release frequency. 3. Inclusion of additional examples of risk insights in the decision-making process.
Pressurized Thermal Shock	The staff issued draft NUREG report, "Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Criteria in the PTS Rule (10 CFR 50.61)," in December 2002. This report documents the results of a multi-year study re-evaluating the technical basis of 10 CFR 50.61.
Probabalistic Risk Assessment of a Dry Cask Storage System	The staff completed a pilot PRA and issued a draft report on integrated risk results. The PRA methodology will be updated and additional studies performed, as appropriate, to aid risk-informing NRC's inspection programs for dry storage of spent nuclear fuel.
NMSS Risk Case Studies	The eight case studies were completed in December 2001. As part of this effort, NMSS held several stakeholder meetings, including a meeting with a diverse set of Stakeholders in October 2001. Also, to gain a broader perspective of risk in the materials and waste arenas, the eight case studies were integrated with other related risk assessments. Major outcomes of the case study effort were: (1) development of a formal set of Screening Considerations that could be used to determine whether an NMSS regulatory activity should be risk-informed, (2) development of a guide for using the Screening Considerations, and (3) and formation of a framework for developing materials and waste safety goals.
Identification of Regulatory Activities Amenable to Increased Use of Risk-Information	Between January and April 2002, the Risk Task Group, in consultation with the NMSS Divisions, used the NMSS Screening Considerations to systematically identify NMSS regulatory activities that are amenable to being risk-informed. This identification of activities will serve as the NMSS road map towards comprehensively risk-informing its regulatory activities. Actual implementation of the activities will be planned, prioritized and budgeted through the PBPM process.
Development of Materials and Waste Safety Goals	As part of the case study effort, NMSS established the feasibility and usefulness of safety goals in the materials and waste arenas and developed a first draft of safety goals. NMSS and RES have initiated a joint effort to continue developing materials and waste safety goals and risk metrics, and to develop other tools, methods, data, guidance and standards necessary for implementing risk-informed approaches in NMSS.

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NMSS Risk Training Program	NMSS has instituted training courses to advance the use of risk assessment and risk management into its day-to-day operations. Tier I and II training courses on risk assessments in NMSS are offered regularly. A Tier III quantitative frequency analyses course is offered through TTC. A second Tier III course on byproduct materials system risk analysis and evaluation has been developed; the pilot and a regular session were offered in FY02 with five more sessions scheduled in FY03. A course on human reliability assessment for materials and waste regulatory applications is being developed
NMSS Risk Communication plan	In April 2002, NMSS revised the "Communication Plan for Risk Informing Materials and Waste Regulations." The Communication Plan describes NMSS' plan for communicating risk information to internal and external stakeholders. The purpose of the plan is (1) to communicate, to external stakeholders, the major points of the program to risk inform materials regulations, in order to increase public confidence, and (2) to communicate, within the NRC, the NMSS Risk Task Group's activities to increase understanding and acceptance of NMSS's risk-informing efforts and to assist NMSS staff in communicating risk-related information to external stakeholders.
Medical Use of Byproduct Material	The final rule amending the regulations regarding the medical use of byproduct material (10 CFR Part 35) became effective on October 24, 2002. The final rule is one component of the Commission's program for revising its medical use regulatory framework to focus the regulations on high-risk medical procedures and to make its regulations more risk-informed and more performance-based. In addition, the staff completed other elements of the program, including the revision of NUREG-1556, Volume 9, "Program-Specific Guidance About Medical Use Licenses," and the revision of four medical inspection procedures to reflect final rule changes to 10 CFR Part 35. Training was conducted for licensing and inspection staff and was made available to staff in Agreement States.
Risk-informed, Performance-based Inspection Procedures for Medical Use of Byproduct Material	The inspection procedures were revised to incorporate all of the Materials Phase II changes and the new 10 CFR Part 35 changes.
Multi-phase Review of the Byproduct Materials Program (Implementation of Phase I and II Recommendations)	The staff evaluated eight recommendations to improve the effectiveness and efficiency and completed further actions for four of the recommendations (i.e., promoting the use of NUREG-1556 series by licensees, providing guidance to staff for TAR process, revising the event evaluation policy (P&P letter 1-57), and promoting broader use of flexiplace by the staff). Further actions (i.e., delegation of Severity Level III cases to the Regional Offices, revision of allegation referral procedures to the States, and to licensees, and periodic counterpart meetings for Regional and IMNS staff) on the other four recommendations were not needed.
Part 70 Integrated Safety Analyses	In accordance with the revised 10 CFR Part 70, each licensee has submitted a plan for conducting its Integrated Safety Analysis (ISA) for NRC staff review. The NRC staff has reviewed and approved all plans. With much stakeholder involvement, the 10 CFR Part 70 Standard Review Plan was finalized in December 2001 and published in March 2002.
Fuel Cycle Oversight Revision Project	In March 2002, the staff provided the Commission a status report on the fuel cycle oversight revision project. This project will be closed at the end of FY 2002, after the staff completes near-term revisions of the Licensee Performance Review process and the guidance for conducting the fuel cycle facility inspection program. Beginning in FY 2003, risk-informed revisions to the fuel cycle oversight program's inspection procedures will be made during normal updates of the inspection program, commensurate with the implementation of the Part 70 revisions. Under this approach, the fuel cycle facility oversight process will evolve in a more risk-informed direction over the next several years.

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10 CFR Part 63	The staff published the final risk-informed, performance-based rule for disposal of high-level radioactive wastes in the proposed geologic repository at Yucca Mountain, Nevada.
10 CFR Part 63 Guidance	The staff published in March 2002 the NUREG-1804, Revision 2, "Yucca Mountain Review Plan (Draft Report for Comment)." The review plan provides guidance to staff on implementing the risk-informed, performance-based regulations of Part 63.
10 CFR Part 63: Specification of a probability for Unlikely Features, Processes, and Events	The Staff published a final rule amending Part 63 to define the term "unlikely" in quantitative terms.
Decommissioning Guidance Consolidation	The Decommissioning Guidance Consolidation Project is reviewing and consolidating existing decommissioning guidance, updating and risk-informing the guidance, as appropriate, in the process. Staff held a public workshop in June 2001 to solicit feedback from the public and stakeholders on the project. Also, staff convened the Volume 1 writing team in June 2001. The staff published Volume 1 (Decommissioning Process) as NUREG1757 for comment in January 2002. Volume 1 was issued in September 2002. The writing team for Volume 2 (Dose Modeling) was convened in January 2002 and the draft was issued for comment in September 2002. The writing team for Volume 3 (financial assurance, record keeping, and timeliness) was convened in July 2002 and the draft will be issued for comment in January 2003.
	As part of the effort to make the fuel cycle oversight program more risk-informed and
	performance-based, the staff completed the revision of Inspection Manual Chapter 2600,
	"Fuel Cycle Facility Operational Safety and Safeguards Inspection Program."

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